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Causality and Meaning in the New Materialism.

By Manuel DeLanda.

At first sight the concepts of causality and meaning seem quite alien to each other, at least in the context of materialist philosophies in which causal relations are thought to exist between mind-independent entities, while meanings are taken to belong exclusively to human minds and human societies. This sharp divide is not characteristic of other philosophies, idealist or empiricist. In an idealist philosophy, like that of Kant and his followers, causality is conceived as a conceptual condition of human experience, together with other concepts like space and time. Hence, causality and meaning can go together. In an empiricist philosophy, like that of Hume and his followers, causality is defined as the observed constant conjunction of two events, like the collision of two billiard balls and the changes in the state of motion of the two colliding balls. Here meaning is also linked to causality via the mediating role of the observer. But for a materialist philosopher, causality is an objective relation in which *one event produces another event*, whether there is a human being witnessing this production or not.¹ Hence, if meanings are conceived as something inherently conceptual or linguistic, their relation with causes becomes problematic.

In this essay I want to argue that the disconnect between causality and meaning is only apparent. These two concepts, on the other hand, need to be re-analyzed in order for their relation to become intelligible to a materialist. Let's begin by enriching the concept of causality to get rid of its ancient connotations of linearity. The formula for linear causality is "Same Cause, Same Effect, Always". Different forms of nonlinear causality can be derived by challenging the different assumptions built into this formula. The word "same" can be challenged in two ways because it may be interpreted as referring both to the *intensity* of the cause ("same intensity of cause, same intensity of effect") as well as to the very *identity* of the cause. Let's begin with the simplest departure from linear causality, the one challenging sameness of intensity. As an example we can use Hooke's Law capturing a regularity in the way solid bodies respond to loads, like a metal spring on which a given weight is attached. In this case the event "changing the amount of weight supported by the spring" is the cause, while the event "becoming deformed" – stretching if pulled or shrinking if pushed – is the effect. Hooke's law may be presented in graphic form as a plot of load versus deformation, a plot that has the form of a straight line (explaining one source of the meaning of the term "linear"). This linear pattern captures the fact that if we double the amount of weight supported by the spring its deformation will also double, or more generally, that a material under a given load will stretch or contract by a given amount which is always proportional to the load.

While some materials like mild steel and other industrially homogenized metals do indeed exhibit this kind of proportional effect many others do not. Organic tissue, for example, displays a J-shaped curve when load is plotted against deformation. A gentle pull on one's lip, for example, produces considerable extension, but after that a much stronger tug results in relatively little additional extension.² In other words, a cause of low intensity produces a relatively high intensity effect up to a point after which increasing the intensity of the cause produces only a low intensity effect. Other materials, like the rubber in a balloon, display a S-shaped curve representing a more complex relation between intensities: at first increasing the intensity of the cause produces almost no effect at all, as when one begins to inflate a balloon and the latter refuses to bulge; as the intensity increases, however, a point is reached at which the rubber balloon suddenly yields to the pressure of the air rapidly increasing in size but only up to a second point at which it again stops responding to the load. The J-shaped and S-shaped curves are only two of several possible departures from strict proportionality, and this implies that the terms "linear" and "nonlinear" are not a dichotomy: nonlinear patterns represent a variety of possibilities of which the linear pattern is but a limiting case.

A stronger form of nonlinear causality is exemplified by cases that challenge the very identity of causes and effects in the formula "Same Cause, Same Effect, Always". When an external stimulus acts on an organism, even on a very simple bacterium, the stimulus acts in many cases as a mere trigger for a response by the organism. A biological creature is defined internally by many complex series of events, some of which close on themselves forming a causal loop (like a metabolic cycle) exhibiting its own internal states of stability as a whole. A switch from one stable state to another, the effect, can in this case be triggered by a variety of stimuli. That is, in such a system *different causes can lead to the same effect*. For similar reasons two different components of a biological entity, each with a different set of internal states, may react completely differently to external stimulation. That is, *the same cause can lead to different effects* depending on the part of the organism it acts upon. An often quoted example is the vegetable hormone auxin, which applied to the tips of a plant stimulates growth but applied to the roots inhibits growth.³ This type of nonlinear causality is referred to as "catalysis" and it is not a monopoly of biological creatures. Though enzymes are indeed the most precise and powerful catalysts on Earth, metallic substances can also play this role in both nature and industry.

Philosophically, what matters about nonlinear causal relations is that they force us to take into account not only an entity's *capacity to affect* but also its *capacity to be affected*. And the latter is not just the passive side of the active capacity to affect but equally active on its own, although depending on activity at another level of organization, that of the components parts. In the case of organic tissue or rubber, for example, their nonlinear response curves are explained by facts about the microstructure of the materials determining their capacity to be affected by a load. And by the time we consider cases like a bacterium its capacity to be affected (depending on the metabolic state it happens to be in at the moment)

dominates its response to external causes, the latter having been reduced to mere triggers. Thus, the crucial change in our conception of causality is contained in the concept of *affect*: the capacities to affect and be affected that characterize objective entities.⁴ The name of the concept is somewhat unfortunate because it connotes something emotional, and there is, to be sure, such a thing as the capacity of humans (and other animals) to be affected emotionally, as well as their capacity to affect others emotionally. But emotions do not have a monopoly on affects, the latter being a characteristic of all things, organic and inorganic, human and non human.

Let me elaborate this important point. When a philosopher believes in the existence of a mind-independent world, as most materialist do (with the exception of many contemporary marxists) he or she needs to specify just what defines the autonomous identity of its contents. This identity is partly explained by a material entity's properties: its mass and weight; its location in space and time; its shape, and so on. Thus, an object like a knife is characterized by its length and weight, and by its being sharp or dull, a geometrical property of the cross section of its blade. Roughly, if this cross section has a triangular shape (that is, if it is pointy) then the knife is sharp, else it is dull. Now, a sharp knife has, in addition, the capacity to cut things, but this characteristic of its identity is different from its properties. The latter are both real and actual: the knife is either sharp or dull right now. The former, on the other hand, are real but not necessarily actual: the knife may never have been used and its capacity to cut may never have been actually exercised, but that does not make it less real. The technical term for a characteristic that is real but not actual is *virtual*. When the knife is used, on the other hand, its capacity to cut becomes actual but, unlike properties that characterize an enduring state, this actualization is always in the form of an event: to cut. And, moreover, the event is always double, to cut/to be cut, because a capacity to affect must be coupled to a capacity to be affected in order to become actual: a knife can cut bread and cheese but not a solid block of titanium. The former, but not the latter, have the capacity to be cut. Finally, an implication of the relational status of affects, is that one and the same thing may possess different capacities depending on the kind of entity with which it interacts. A knife has the capacity to cut when interacting with bread; the capacity to kill when interacting with a living animal; and the capacity to murder when interacting with a human being.

The relational character of affects implies that the mind-independent world that the New Materialists believe in is not closed and finished. Unlike the properties of things, which can be listed more or less exhaustively, capacities form an open ended set, since we can never know what a thing may be capable of when interacting with a million of other things. Moreover, the set of properties itself is open ended, although in a different way. Most properties of medium sized objects, that is the kinds of objects we can perceive with unaided senses, are what is called *emergent*. That is, these properties are the result of an object's components interacting in specific ways, but they themselves are not possessed by the components. The concept of an emergent property was born in the field of

chemistry in the late eighteenth century. Chemists perform analytical operations on substances, such as analyzing water into its component substances, oxygen and hydrogen. But they also perform synthetic operations, such as placing oxygen and hydrogen gases in the right proportions and using an electric spark to force them to combine into water. Hence, chemists routinely witness that the properties of a substance disappear when broken down into components but reappear, or emerge, when these are combined again. And since properties are partly responsible for capacities (a knife must be sharp to be capable of cutting) this applies to the latter as well: both oxygen and hydrogen are fuels, that is, if added to a fire they will stimulate combustion; but water has the opposite capacity, it puts out fires. Because the relation part-to-whole that yields emergent properties is recursive – a given whole with emergent characteristics can become one of the components of a more complex whole with different and novel characteristics – the list of emergent properties is also open ended. Chemists have been producing novel substances through synthesis at an increasingly higher rate, to the point where their domain increases every year by hundreds of thousands of new substances. In other words, there are every year more substances than the entire chemical community can study, and this has the consequence that an honest chemist cannot believe in the final truth: that goal, the complete description and explanation of all substances and chemical reactions, recedes ever further into the horizon.

The importance for materialism of the concept of an emergent property, and that of the emergent capacities that these properties sustain, cannot be exaggerated. But the history of these concepts contains episodes of mystification that have made philosophers skeptical of them. As just mentioned, it was chemists who introduced the concept but it remained confined in this field until John Stuart Mill gave us a definition: an emergent property is a property of a whole that is more than the sum of its parts.⁵ Mill did not use the word “emergent”, a word that was introduced in 1875 by another philosopher, George Henry Lewes, in the context of a discussion of joint causes and their effects. When two separate causes simply add or mix themselves in their joint effect, so that we can see their agency in action in that effect, the result is a mere “resultant” but if there is novelty or heterogeneity in the effect then we may speak of an “emergent”.⁶ Both authors viewed the difference between physics and chemistry as pivoting on *the possibility of explanation*: while in physics to explain an effect is to deduce it from a general law, in chemistry deduction is not possible because of the existence of novelty in the effect. To know what effect the combination of two causes will have, what substance will be synthesized from the interaction of two different substances, for example, one needs to actually carry out an experiment. Mill did not think that this was a reason for despair: in due time chemical laws could be discovered that made the properties of water, for instance, deducible from those of oxygen and hydrogen. But to Lewes this possibility implied that water would cease to be an emergent and would become a resultant. In other words, something is an emergent only to the extent that we cannot deduce it from a law and it ceases to be so the moment a law becomes available. This is an unfortunate conclusion, one that involves a serious

misunderstanding of the nature of explanation in general and of causal explanation in particular.

The philosopher Samuel Alexander went so far as urging his followers to accept emergent properties with “natural piety”, that is, accepting them as brute fact, in a way that admits of no explanation.⁷ Despite some mystical overtones in the work of Alexander, such as his arrangement of emergent levels of ascending grade into the sequence space-time, life, mind, deity, neither he nor the other emergentists accepted the existence of entities like a “life force”, “vital energy”, or “entelechy”. In fact, the notion of emergence was for them a way of get rid of those suspect notions.⁸ The real problem with their position, what made the concept of emergence suspect of mysticism, was their rejection of explanation. Contemporary realist philosophers, on the other hand, have embraced the concept of “emergent property” precisely because they do not see any problem in accounting for irreducible properties through some mechanism. As the philosopher Mario Bunge puts it, the “possibility of analysis does not entail reduction, and explanation of the mechanisms of emergence does not explain emergence away.”⁹ The rehabilitation of causal explanations in recent decades is partly due to the work of philosophers like Bunge who have rid the concept of causality of its connotations of linearity and homogeneity.

Before moving to the question of meaning and its place in materialist philosophy, let's give a more detail account of the concept of explanation. As just argued, an emergent property must be accounted for by giving mechanisms of emergence, that is, by showing how the *causal interactions between the components of a whole* result in the creation of novel properties. But in addition to a concrete mechanism there is sometimes the need to add some factors that are *mechanism-independent*. As an example let's take the periodic circulatory patterns that characterize certain wind currents (like the Trade Winds or the Monsoon) and the underground lava flows that drive plate tectonics. These circulation patterns, known as “convection cells”, are emergent phenomena enjoying a large degree of stability: the Trade Winds brought Columbus to America, and continue to display emergent order to this day, while the convection cells of lava underlying plate tectonics have been circulating for millennia. More importantly, the same stable periodicity can be observed in phenomena that are entirely different in detail, such as certain chemical reactions that rather than ending in a final steady-state of their final products, they approach a state at which one chemical substance is exclusively produced and then a different substance is produced, alternating to a perfect beat. The causal mechanism behind these so-called “chemical clocks” (a mechanism based on autocatalysis) is entirely different from the mechanism behind convection cells (based of differences in temperature and density.) Hence, the explanation of emergent rhythmic patterns needs something in addition to causal interactions. This something else is *the objective structure of a space of possibilities*, a structure given in many cases by a *distribution of singularities*.

The simplest singularities (maxima and minima) were discovered in the eighteenth-century by the mathematician Leonard Euler using his invention, *the calculus of variations*. By the mid-nineteenth century all the different processes studied by classical physics (optical, gravitational, mechanical, electrostatic) had been given a variational form and were therefore unified under a single least principle: the tendency to minimize the difference between kinetic and potential energy. In other words, it was discovered that a simple singularity structured the space of possibilities of all classical processes. The unification of all known fields of physics under a single equation from which effects could be derived deductively led in some philosophical circles to doubt the very usefulness of the notion of a causal mechanism: if we can predict the outcome of a process using variational methods then what is the point of giving a causal explanation? But as Euler himself argued explanations in terms of singularities and causes (or of final and effective causes) are not mutually exclusive but complementary. Thus, we said above that a living cell may have several available stable states and that different external causes may act as triggers or catalysts that force the cell to adopt one of these states. In this case, in order to fully explain the phenomenon we need both the singularities defining these stable states (e.g. a minimum in the concentration of a metabolic product) as well as the triggers.

In the late nineteenth century singularities began to appear in other branches of mathematics like the study of topological spaces, abstract spaces where the familiar notions of length, area, and volume are meaningless. The mathematician Henri Poincare, for example, explored the relations between the maxima and minima of the variational calculus and the newly discovered topological singularities. More specifically, he used topology to investigate the structure of the space of possible solutions to specific mathematical models. Since these models are used to predict the future states of a particular physical process, each solution to the equation representing one state, the space of all solutions is known as *state space* (or “phase space”). The structure of state space, Poincare found, is defined by different types of singularities. Some have the topological form of a point, much like the maxima and minima of the variational calculus. The existence of a point singularity in the state space of a process defines a tendency to be in a steady-state, that is, either a state of no change or one in which change takes place uniformly (as in the steady flow of a liquid). Singularities with the topological shape of a closed loop (limit cycles) define stable oscillations, that is, the tendency of a process to have a precise rhythm and to return to this very rhythm when disturbed by external shocks.¹⁰ Poincare even got a glimpse of the more exotic singularities that today are referred to as “strange” or “chaotic” attractors.¹¹ Explaining a given emergent effect like a convection cell or a chemical clock involves describing not only a concrete mechanism but also the singularities – limit cycles, in this case – that structure their associated possibility space.

In the case of mechanisms it was important to distinguish linear from nonlinear causality to counteract the criticism that the homogenous effects of the former made causal explanation of emergence impossible. In the case of

mechanism-independent structure a similar distinction must be made to counteract the idea that explanation is deduction from a general law, and that emergence implies the absence of such a law. The state space of linear differential equations is structured by a single point singularity while that of nonlinear equations can have many singularities of different types. Given that the tendency to approach a singularity is entirely deterministic knowing the structure of a linear state space is sufficient to deduce what the final state of a process will be. But with multiple singularities, each with its own sphere of influence or “basin of attraction”, that knowledge is not enough. There are several possible tendencies and several possible outcomes, so the one currently actualized is in large part a product of the *history* of the process. In other words, the current state cannot be deduced from the equation alone because it depends on the historical path that the process followed.

Let's move on to trace the link between causality and meaning. As was remarked above, to an idealist for whom causality is a concept that organizes experience, the link is direct: to be able to perceive two events as having a causal connection, we must understand the meaning of the concept. But when causality is defined as the objective production of one event by another event, with no connection whatsoever to human experience, meanings would seem to be entirely irrelevant. This impression is wrong. The seeming absence of a connection is due to two grave mistakes: a semiotics that privileges symbols at the expense of other signs, and a confusion between two senses of the word “meaning”, one referring to the *signification* of linguistic signs, the other to the *significance* of actions. Let's begin with the first problem: an impoverished semiotics. At the end of the nineteenth century Charles Sanders Pierce introduced a classification of signs that included three categories: symbols, signs that stand for what they represent by a conventional relation; icons (e.g. drawings, diagrams, maps) that stand for what they represent by a relation of similarity (or isomorphism); and finally, *indices or traces*, signs that indicate what they stand for by having a causal relation to it.¹² The classic example of an index is the relation between fire and smoke (the presence of smoke indicates that of fire) but other examples include fingerprints and footprints, tree rings, symptoms of disease, facial expressions, and I would argue, most of the information that reaches our senses from the world. The semiotics that grew around the linguistics of Saussure, privileging as it did conventional symbols (the famous arbitrariness of the signifier), not only neglected all pictorial or graphic signs, but it entirely forgot that there are signs that point to what they stand for by having a causal relationship with it. Had these “natural signs” become part of our current semiotic theory, the link between meaning and causality would not seem as tenuous as it does today.

But the main source of confusion in this regard is that the word “meaning” is used in multiple ways and that philosophers and social scientists do not keep the different senses apart. When someone asks, in the midst of a conversation “What do you mean?.” this is normally a request for the dictionary definition of a word, or in the case of a sentence containing an ambiguous term, a request for disambiguation. In both cases the word “meaning” is used to denote the semantic

content of a word or sentence, that is, its signification. But if a distraught friend comes to us for advice and utters the sentence “My life has no meaning,” it would be foolish to take that as a request for semantic content. Rather, what our troubled friend is trying to say is “My life feels unimportant, irrelevant, it feels like I do not make a difference to anyone.” In this case, the word “meaning” is used to denote significance. That the two words are entirely different can be seen from the fact that something without signification is termed “nonsensical”, whereas something without significance is termed “trivial”. If the word meaning in the expressions “this word has a meaning” and “this life has a meaning” are two entirely different words, then using them as if they were the same word can lead to erroneous conclusions. In particular, it may lead to the mistake of thinking that everything arounds us, everything that makes us feel relevant and capable of making a difference, is a linguistic matter, and therefore that our activities are nothing but an enacted text.

The connection between causality and meaning can now be stated: it is a link with the notion of significance, not of signification. The connection can be easily grasped if we think of the practices in which these two terms are involved: interpretation and explanation. To interpret a text, in the way in which priests of different religions hermeneutically analyze sacred texts, is to answer questions about semantic content. To explain an event, on the other hand, is to single out the factors that made a difference in the outcome, the factors that were important and relevant, and to push to the background those factors that are insignificant. Much as social scientists routinely confuse signification and significance, they use the term “interpretation” when the correct one is “explanation.” Thus, when a sociologist observes two chemists arguing after a laboratory experiment in which the outcome is not clear, they tend to characterize the situation as one in which each chemist has a different interpretation of what happened. This allows them to think of the situation as involving something linguistic and hence, as being ultimately determined by social conventions. But in reality the two chemists are arguing because they have different explanations of the outcome of the experiment, and even though they are using language in their argument, what they are arguing about is what causal factors explain the surprising or unexpected outcome: is it that the two substances invoked in the chemical reaction were not adequately purified and the impurities influenced the result.? Or is it that the temperature or pressure affecting the reaction caused it to yield a different product.? Or was it something else that they do not know how to control for.? In other words, the argument is not about the signification of words or sentences, but about the significance, importance, or relevance of the different causal factors.

At this point we must extend the concept of explanation to apply it to social problems. So far, giving an explanation has been characterized as supplying a causal mechanism, and in some cases, a mechanism-independent factor, such as the singularities structuring a possibility space. Explanations can be conceived as answers to Why questions, but Why questions about human behavior and social events often demand answers that are not causal. To return to our example, when

two chemists argue about the outcome of an experiment, in addition to having an honest disagreement about how different causal factors make a difference to the outcome, the two scientists behavior needs to be explained by giving *reasons* (such as the shared values of different sub-communities of chemists) and *motives* (such as advancing their respective careers.)¹³ Let me illustrate this with another example. In 2005, the city of New Orleans was flooded in one of the worst urban catastrophes of recent times. Now, if we ask the question “Why was New Orleans flooded?” the answer is a causal one: because hurricane Katrina clashed against the coast, pushing large amounts of water into the Mississippi river, causing it to overflow and overwhelm the levee system. But if we ask instead “Why were poor neighborhoods in New Orleans disproportionately affected?” we need to give not causes but reasons. Specifically, we need to explain that because water seeks the lowest level, property in highland tends to be in more demand than that in lower lying areas. As a consequence, prices in the latter will be lower, and poor people will tend to concentrate there. Prices, as collectively set by demand and supply, provide reasons to buy or sell. Finally, if while watching our television screens we see a person from a rich neighborhood trapped in a roof of a poor section of town and ask “Why is that person doing in that neighborhood?” the answer could be “He is a doctor, tending to poorer patients, and he was trying to rescue some of them when he was overwhelmed by the waters.” In this case, we must give a motive as the explanation. In what follows I will concentrate on causes, but it is important to keep in mind that significant factors may also include reasons and motives.

One philosophical problem that depends for its formulation on the distinctions just drawn is the problem of subjective experience. On one hand there are philosophers who believe in the linguisticity of experience: the way we make sense of visual perception, for example, is by assigning each percept to a linguistic (or conceptual) category. Some philosophers (Kant) believe some of these categories are inborn, while others believe that we cut out the world using socially transmitted categories (social constructivists.) This not only implies that human experience is drastically different from that of other mammals (since they do not possess language) but that the experience of human beings from distant cultures is also radically different: since symbols are arbitrary and conventional, and since each culture has its own symbols, then each culture literally lives in a different world. Now, it is certainly true that perceptual experience must be *meaningful* to the subject, but this refers to significance not signification. How we make sense of what the world presents us depends on being able to sort the contents of experience into that which is important and relevant, and that which does not make a difference to us now. The former becomes figure, the rest of the insignificant stuff is thrown together into an undifferentiated background. This sorting out of the contents of experience into that which makes a difference and that which does not can be performed by non-human animals, and this implies that there is some continuity between their visual experiences and ours. To connect this point with the ideas that started this essay, what is significant in the surroundings is that which has the capacity to affect (and be affected by) an animal. In one model of

animal visual perception, for example, what animals see, the part of their visual experience that affects their behavior, is the opportunities and risks that their environment affords them. These are referred to by the term *affordances*.¹⁴

Let me give some examples of affordances. A solid piece of ground affords or supplies a walking animal with the opportunity to move on it, but the surface of a lake does not, at least if the animal is large enough. But because affordances are relational (much like affects are) that same water surface can provide a small insect with the opportunity to walk. A piece of ground before an avalanche, affords an animal movement in all directions, while after the avalanche it may be so cluttered that opportunities for passage are limited and have to be negotiated. A cliff, on the other hand, affords a walking animal the risk of falling and injuring itself, a risk that is not afforded to a flying animal. A hole on the side of the mountain affords a rabbit a place to hide from a pursuing fox but only if it is of the right size: large enough to fit the rabbit but not too large that the fox can also fit. The concept of affordance is very important because it brings together causality (capacities to affect and be affected) and meaning (significance). It is also an interesting concept for architects because in the original model information about opportunities and risks is transmitted in nature by *surface layouts*. With the exception of transparent or translucent objects, most opaque ones present us only with their outer surfaces. An animal can study these surface layouts to perceive the difference between a cluttered piece of ground and an uncluttered one; it can also perceive the sudden discontinuity between the ground and the vertical wall of a cliff; as well as the difference between a hole (illuminated as a concave surface would) and a protuberance of the same shape (illuminated as a convex surface would.) Similarly, architects depend on surface layouts not only to functionally and aesthetically organize space, but also to communicate this functionality to the users of architectural structures: enclosing walls afford an obstacle to those outside the space, but for the same reason afford privacy to those inside; doors afford passage from one enclosed space to another; hallways afford passage from one area to another; staircases afford passage from one floor to another. Thus, an architectural structure can be conceived as being meaningful to its users without reducing it to a text, a maneuver that flattens the analysis and deprives the structure of its materiality. Surface layouts, in natural as well as in humanly built environments, can be conceived as indices, as natural signs that indicate the capacities to affect and be affected of the objects bound by those surfaces.

Let's conclude this essay with some general remarks. Bringing together causality and meaning forces us to distinguish two forms of human culture: symbolic and material culture. The former is the familiar one involving narratives of different kinds (foundational legends, stories of survival, fiction); a host of rhetorical figures and the practices of persuasion in which they figure; conventional units of measure; rules constituting the identity of games like chess, and so on. Clearly, symbolic culture is important and shapes a large part of our daily lives. But in addition, there is the culture of blacksmiths, carpenters, potters, cooks, tailors, and the thousand other crafts practiced around the world. Although

the practitioners of these crafts may approach their materials (metal, wood, clay, food, cloth) using some symbols (such as the link between different metals and different planets) they spend most of the time performing *causal interventions* into the materials: melting and hammering metals; cutting and joining wood; molding and baking clay; preparing sauces; sawing and fitting clothes. Because of the overlaps (and even sometimes, the mutual interpenetration) between the two forms of culture, it is hard to give absolute criteria to distinguish them, but with some care some defining characteristics can be glimpsed. First, as forms of culture the content of the different practices must be transmitted across generations. There are two ways in which this can be done. One is to transmit cultural content through lectures or books, the other is to teach it by example and learn it by doing. This distinction is connected to the two forms of knowledge distinguished by the philosopher Gilbert Ryle: *knowing that and knowing how*.¹⁵ The former is about linguistically coded knowledge, such as that expressed by declarative sentences: knowing that Columbus discovered America, or knowing that the hydrogen atom has only one proton in its nucleus. The latter is about embodied knowledge, the skills and abilities that a master craftsman helps to develop in an apprentice by first showing him or her how an operation on materiality is performed, then by supervising the day to day exercise of that operation. This is how knowing how to solder two metals, or how to join to pieces of wood, is taught and learned.

These two forms of knowledge are not mutually exclusive. We use language to theorize about know how, and words may be used in the teaching of skills to direct the attention of the learner to subtle differences in performance, or even just to encourage learning. And conversely, some of the basic infrastructure of symbolic culture in literate societies is constituted by skills, like knowing how to read or knowing how to write. Nevertheless, the two are separate forms and may exist without the other. The teaching of skills by example need not involve a single word, hence does not depend on signification, but it does involve assessments of significance. Thus, a master blacksmith must inculcate in his disciples a sense of what makes and what does not make a difference in their practice: does letting a metal object cool down slowly (annealing) as opposed forcing it to cool down faster (quenching) make a difference in the final product.? Yes, the first operation yields a ductile metal with the capacity to yield without breaking, the second a rigid metal with the capacity to hold on to a shape. The first is needed for the body of a sword, the second for its edge. Although this assessment, as was just now expressed, used words, we can imagine a blacksmith teaching these distinctions to someone from a different linguistic background entirely by applying the operations to an actual piece of metal, and then showing the disciple the different results: see, rigid metal is brittle, it chips easily; ductile metal dents easily but it won't break. Significant differences in process that lead to significant differences in product can be taught by example and learned by doing.

Architects, whose practice exists at the intersection of these two forms of culture, must never yield to the pressure of making everything around us a linguistic matter. And in order to do so, they must operate with an enriched

concept of causality that includes all capacities to affect and be affected, as well as with a better analyzed concept of meaning in which the distinctions between signification and significance have not been elided. Only then will the discourse of architectural theory be able to leave the wasteland of the late twentieth-century.

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